Disappearing Working Capital

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Abstract

The latter half of the 20th century is characterized with an unprecedented technological development in the human history. This paper examines whether the development in information technology (IT) has had a real consequence on the working capital management of U.S. listed firms over the past five decades. I find that the annual mean (median) value of cash conversion cycle (CCC) of U.S. firms has sharply declined from 105.3 (96.9) days in the 1970s to 64.2 (53.2) days in the 2010s due to a real improvement in inventory and payment cycle. The decline is systematic across all industry and cohort groups and is not affected by accounting-based earnings management. Moreover, I find that one percent increase in IT spending is associated with a reduction of CCC by 0.17 days. I further point out that this real (vis-à-vis accounting) improvement in IT and working capital management re-shapes the asset structure of average U.S. firms, reduces their net working capital *balance* from 30.5% of average total assets in the year 1970 to only 4.6% in the year 2017, reduces working capital *accruals* from 18.8% of earnings in the 1970s to only 5.4% in the 2010s, and changes the relationship between earnings and cash flows over time.

Keywords: information technology, cash conversion cycle, working capital, asset structure, cash holdings, accruals

JEL Classifications: M15, M40, M41

Data Availability: Data are available from the public sources cited in the text.

I. Introduction

Working capital (noncash current assets less current liabilities other than short-term debt), is an important source of financing and investment. For example, firms finance major portions of their capital needs through accounts receivables and payables. Ng, Smith, and Smith (1999) show that vendor financing in the U.S. accounts for approximately 2.5 times the combined value of all new public debt and equity issues in the 1990s. Inventories are firms' essential short-term investments that enable future sales to occur but these short term investments increase firms' financing needs. Therefore, managers optimize their inventory level to avoid over- or under-investment problems as a part of their strategic decision. Together, firms' net working capital choices reflect the efficiency of firm-specific strategic decisions which varies cross-sectionally across firms, industries and countries.[1] For example, Shin and Soenen (1998) compare the case of Walmart and K-mart. Beginning with similar levels of net working capital in 1994, Walmart and K-mart have each evolved to carry cash conversion cycles of 40 days and 61 days, respectively. Consequently, K-mart faced an additional $198.3 million in financing expenses per year, which has contributed to their bankruptcy in 2002 (p 37). Given the severity of failure to manage working capital, it is not surprising that CFOs rank working capital management as one of their top three priorities in day-to-day operations (2016 Finance Priorities Survey), and that popular press such as *CFO Magazine* annually ranks top 1,000 companies based on their respective efficiency in working capital management.

In this paper, I hypothesize that the evolution of information technology over the past half a century has changed the way U.S. firms manage working capital. Since the first computer ENIAC (Electronic Numerical Integrator And Computer) built in 1946, the computing power in human possession has doubled approximately every two years (e.g., Moore's Law). A computer is now at the center of virtually every economic transaction in the developed world, changing the way information is transmitted, collected and analyzed (Varian, 2016). For example, advances in information technology has changed the way payments are made between business-to-business (B2B) and business-to-customer (B2C). Most companies no longer

[1] Summary statistics reported in Rajan and Zinagles (1995) show that the amount of net working capital differs among G7 countries from 10.7% of total assets in Canada to 29.9% in Italy.

send their invoices via paper mail. Payments are made electronically and instantaneously, thereby reducing lag time and expediting payment cycle. The share of consumer payments made by paper checks have fallen from 77% in 1995 to 36% in 2006, while the share of Automated Clearing Houses (ACH) has increased substantially (Schuh and Stavins, 2010). Similarly, B2B procurement processes have been electronically integrated over the past decades (Mukhopadhyay and Kekre, 2002) and U.S. manufacturing firms invest over $5 billion a year on new information technology in their plants (Banker, Bardhan, Chang and Lin, 2006). Evolving information technology and the advancements in logistics have also changed the way inventories are handled. According to United Nation's (UN) International Civil Aviation Organization (ICAO), global air freight traffic has increased from less than 20 ton-kilometers in the 1960s to over 180 ton-kilometers by the year 2013. Online sales now account for up to 14% of all U.S. retail sales. It has become a common practice for suppliers and buyers to share information on inventories (Cachon and Fisher, 2000) and jointly manage production. Today, *Just-in-Time* (*JIT*) is considered an old rubric from the 1980s. At every corner of U.S. industries, artificial intelligence (AI) personalizes advertisement, chat with real customers, manages inventories, and automates logistics. According to CBS News, "AI-powered supply chain and pricing solutions are often the decisive differentiator between profit and loss, and are eminently important to survive in a competitive market"[2]. High-tech inventory management, advanced logistics, and individually-tailored advertisements reduce the amount of inventory sitting in company's warehouse.[3]

Concurrent with the advances in information technology and logistics, I find that the average U.S. firms have become increasingly more efficient in their working capital management over the past five decades. The annual mean (median) value of cash conversion cycle (CCC) for U.S. listed firms has sharply declined from 105.3 (96.9) days in the 1970s to 64.2 (53.2) days in the 2010s. That is, U.S. listed firms have decreased their cash conversion cycle by 1.16 days each year between the years 1970 and 2017. This

[2] Layne, Rachel. "AI is taking retailing to new dimensions." CBS News, CBS Interactive, 28 Nov. 2017, www.cbsnews.com/news/ai-is-taking-retailing-to-new-dimensions/.

[3] For example, *Amazon.com* handled over 7.1 million transactions on 2017 Black Friday alone and sold over 140 million items during the 2017 Thanksgiving weekend, all of which represents faster inventory cycle that deemed impossible during the 1970s.

trend is supported by a continuous and sustained decrease in the annual mean (median) value of days inventories outstanding (DIO) from 89.0 (79.8) days in the 1970s to 63.4 (39.7) days in the 2010s. Moreover, the annual mean (median) value of days payables outstanding (DPO) increase from 38.4 (29.9) days in the 1970s to 59.2 (38.3) days in the 2010s. These trends suggest that improvement in inventory management and delaying cash payments have contributed to a sustained and continued decline in cash conversion cycle of U.S. firms over the past half a century.

This study has two primary objectives. First, I explore potential explanations for this long-term trends. I hypothesize that the decline in CCC is attributable to a real improvement in the efficiency of working capital management following the development of information technology. However, I acknowledge that there may be potential alternative explanations. First, it is possible that the observed decline in the CCC is due to differences in industry. For example, the U.S. economy has shifted from manufacturing to knowledge-based one over the past half a century (Srivastava, 2014). Since firms in service industries are less likely to require as much working capital as firms in manufacturing or trading industries, it is possible that a surge in service industries contribute to the decline in the CCC over time. Second, Fama and French (2004) argue that characteristics of firms listed after 1980 are fundamentally different from those that existed before. Similarly, Srivastava (2014) reports that changes in sample firm composition over the period 1970-2009 contribute to changes in earnings quality over time. Moreover, this change in sample firm composition may also be correlated with industry membership (e.g., more service industry firms over time). Therefore, I examine whether the observed decline in the CCC is attributable to a change in sample firm composition. Third, changes in accounting practice (vis-à-vis real improvement) may contribute to the decline in the CCC over time. For example, a number of prior research point that the earnings quality of U.S. firms has deteriorated over time (e.g., Collins, Maydew, and Weiss, 1997; Cohen, Dey and Lys, 2008; Srivastva, 2014; Bushman, Lerman and Zhang, 2015). Cohen, Dey and Lys (2008) argue that accrual-based earnings management has steadily increased from the year 1987 until the passage of Sarbanes-Oxley Act (SOX) in 2002. Hence, I also examine whether the intertemporal decline in the CCC is explained by earnings management or poor financial reporting. Lastly, I directly test whether the development in information technology is associated with the decline in CCC. Since 2003, the Census Bureau annually surveys all companies with at least 500 paid employees about their business spending for information and communication technology (ICT) equipment and computer software. The Census Bureau annually reports the total spending on ICT by 2-digit NAICS industry. Therefore, I use this Census data as an exogenous proxy to examine whether the development in information technology is associated with the decline in CCC over the sample period.

The empirical results provide the following stylized facts. First, I find that the intertemporal decline in CCC is persistent in all industries. For example, the annual mean value of CCC declines in both consumer non-durable (Fama-French industry 1) and durable goods (Fama-French industry 2) industries from 114.0 and 126.9 days in the 1970s to 87.2 and 86.6 days in the 2010s, respectively. The most and least significant declines are in business equipment (Fama-French industry 4) and utilities (Fama-French industry 9) industry, respectively, where the annual mean value of CCCs decline from 160.6 days and 36.5 days in the 1970s to 60.8 days and 27.5 days in the 2010s. These result show that industry membership does not fully explain the intertemporal decline in CCC over time.

Second, the decline in CCC is not explained by the change in sample firm composition. For example, a subset of 278 firms that survive continuously from 1970 to 2017 decrease their CCC from 108.8 days in the 1970s to 76.9 days in the 2010s. Similarly, the cohort of firms that appear in Compustat database beginning 1970s and 1980s, respectively, reduce their CCCs from 101.3 days and 89.1 days in the 1980s to 71.3 days and 80.4 days in the 2010s. On the other hand, the post-1990s group of firms appear in the Compustat sample with an already low-level of CCC, but rather increase their CCC over time.

Third, opportunistic accounting practice does not explain the intertemporal trends in CCC. Note that managers' biased accounting treatment in one period reduces their ability to make similar treatments in subsequent periods (e.g., reversal) (Hunt et al., 1996; Barton and Simko, 2002; Baber, Kang, and Li, 2011). Therefore, a long-term trend over a few decades cannot be explained by an opportunistic accounting practice. Nevertheless, I re-examine the trends based on firm-level 5-year rolling average CCC and reaffirms the robustness of the downward trend.

Lastly, I directly test the association between the evolution of IT and CCC. Specifically, I find that business spending for information and communication technology (ICT) equipment and computer software is significantly and negatively associated with CCC, after controlling for potential alternative explanations. Specifically, one percent increase in IT spending is associated with a reduction of CCC by 0.17 days, after controlling for financial reporting quality, financial health, firm size, growth, and industry and cohort membership. Together, these evidence suggest that the intertemporal decline in CCC is attributable to a real improvement in the efficiency of working capital management following the development in information technology.

A second, and perhaps more important, aspect of my study is to demonstrate that the development of IT and the associated decline in CCC has direct effects on the U.S. firms' asset structure, accruals, and earnings-cash flow relationship over time. First, intertemporal reduction in DIO and increase in DPO is likely to reduce short-term liquidity of U.S. firms. Therefore, I expect cash balance to increase over time due to a precautionary motive given the costly external capital market (Opler, Pinkowitz, Stulz, and Williams, 1999; Almeida, Campello and Weisbach, 2004; Bates, Kahle and Stulz, 2009). Consistently, I find that the annual mean value of cash balance at U.S. firms sharply increase from 4.2% of average total asset in the 1970s to 17.6% in the 2010s. Moreover, I show that the effect of decreasing CCC on cash holding is incremental to transaction motive (Miller and Orr, 1966), repatriation tax motive (Foley, Hartzell, Titman, and Twite, 2007; Hanlon, Lester and Verdi, 2015; Gu, 2017), or agency cost of cash holding (Jensen, 1986). These findings shed different perspective on recent media and political criticisms towards increasing corporate cash holdings[4], and suggest that real changes in economic environment necessitates the increased cash holdings at U.S. firms. Second, intertemporal reduction in CCC is likely to reduce net working capital *balance* of U.S. firms. Consistently, the annual mean value of net working capital balance declines from around 28.9% of average total assets in the 1970s to only 6.5% in the 2010s. In other words, the trend suggests that the net working capital balance of U.S. listed firms is disappearing at a rate of

[4] For example, *Forbes* article "Tax Multinationals' Excess Cash" (May 24, 2015) argues that "Multinationals have too much cash. So we should tax it away from them".

statistically significant 0.6% of average total assets each year. The decline is mostly in the current operating asset (49.4% of average total assets in the 1970s to 27.4% in the 2010s), with account receivables balance declining from 21.8% of average total assets in the 1970s to 13.4% in the 2010s, and inventory balance declining from 25.7% of average total assets in the 1970s to 10.1% in the 2010s.

Second, under clean surplus accounting, the balance sheet and income statement must articulate (e.g. Barton and Simko, 2002; Baber, Kang, and Li, 2011). That is, the first difference in net working capital balance *is* working capital accruals. As a result, decreasing working capital *balance* leads to decreasing working capital *accruals* in recent periods: the mean value of working capital accruals is reduced from 3.0% of average total assets in the 1960s to 0.003% in the 2010s[5]. Moreover, working capital accruals as a proportion of change in sales, change in expense, or earnings all decline from 18.3%, 17.7% and 18.8% in the 1970s to only 3.6%, 6.7% and 5.4% in the 2010s. These trends suggest a significant shift in the 'normal' accruals-generating-process where accruals time-series is often modeled as a function of change in sales (e.g. Jones, 1991; Dechow, Kothari and Watts, 1998; McNichols, 2002).

Lastly, because earnings[6] is the sum of accruals and cash flows, the intertemporal reduction in working capital accruals alters the relationship between earnings and cash flows in a substantial way. The decline in the magnitude of working capital accruals narrows the gap between operating income and operating cash flows, which in turn, leads to a high correlation between operating income and operating cash flows. The Pearson (Spearman) correlation between operating income and operating cash flows increase from 0.382 (0.365) in the 1960s to 0.901 (0.742) in the 2010s. Together, the small magnitude of accruals and the high correlation between earnings and cash flows indicate that most earnings are now cash-based earnings. Note that practitioners often consider the high correlation between earnings and cash flows as a characteristic of high-quality earnings (Dichev, Graham, Harvey, Rajgopal, 2013)[7]. The apparent

[5] Again, the discrepancy between the mean and median value is driven by the zombie firms in the upper quartile of current operating liabilities.
[6] I use the term operating income and earnings interchangeably in this paper.
[7] Anecdotal evidences suggest similar perception. For example, 2018 CFA Program Level II Curriculum Book writes that "the analysts' most pressing concerns include the following: Are Nestle's operating earnings backed by cash flow? …" (E25), naming high earnings-cash flows correlation as the first of analyst's concerns.

improvement in earnings quality, however, has arisen not because of an improvement in the financial reporting system, but from greater efficiency in working capital management. As a result, it is rather inappropriate to call the higher earnings-cash flows correlation as an indication of improvement in earnings quality.

The rest of this paper is organized in the following way. In Section 2, I explain the sample selection procedure, define variables, and show that the development in information technology has reduced the CCC of U.S. firms over the past 53 years. I also rule out various alternative hypotheses. Section 3 provides implications to accounting research. Specifically, I show that the real improvement in information technology has reduced the overall cash balance at U.S. firms over time. I also show that there has been a reduction in the net working capital balance and working capital accruals over time. These intertemporal trends affect a widely-used proxy of earnings quality (earnings-cash flows correlations) over time. Section 4 concludes and discusses future research avenue.

2. Intertemporal Trends in Cash Conversion Cycle

2-1) Sample Selection and Variables

To examine intertemporal trends in the efficiency of working capital management over the past five decades, I first download all firm-year observations from *Compustat* database over the period 1970-2016. Out of 409,7167 firm-year observations in the Compustat universe, I drop foreign firms (30,115), non-NYSE, AMEX, or NASDAQ firm (160,991), financial and public administration firms (60,212), and observations with missing variables to calculate CCC and working capital (24,421). CCC is defined following Dechow (1994). Working capital is defined as the difference between current operating assets and current operating liabilities, divided by average total assets, following Richardson, Sloan, Soliman and Tuna (2005). Earnings (E) is defined as operating income before depreciation divided by average total assets. Cash flow from operation (CFO) is defined as the difference between earnings and working capital. My final sample consists of 133,977 firm-year observations between the year 1970 and 2017 as described in Panel A of Table 1.

[Insert Table 1 Here]

Panel B of Table 1 provides summary statistics of main variables. All variables in summary statistics are scaled by average total assets, except CCC, DSO, DIO and DPO. The mean value of cash conversion cycle (*CCC*) is 79.6 days. The mean values of days sales outstanding (*DSO*) and days inventory outstanding (*DIO*) are 57.3 days and 71.6 days, respectively. On the other hand, the days payables outstanding (*DPO*) is 51.0 days which is slightly smaller than *DSO*. The mean value of *WC* shows that the cross-sectional, time-series average of U.S. firms' net working capital (*WC*) is 16.3% of total assets. The mean value of working capital accruals (ΔWC) is 0.015 which is similar to RSST (2005). The mean value of operating income (*E*) is 0.104, showing that U.S. listed firms are profitable on average. However, the mean value of operating cash flows (*CFO*) is -0.013 which is consistent with Klein and Marquardt (2006) who document the deterioration real firm performance as measured by operating cash flows. Since these summary statistics are cross-sectional and time-series average, I explore whether there has been any change in their annual values over time in the following sections.

2-2) Cash Conversion Cycle

Consistent with the advancements in information technology in the past decades, I postulate that the working capital management has become more efficient at average U.S. firms over the past half a century. I examine the efficiency gain with days sales outstanding (DSO), days inventory outstanding (DIO), days payables outstanding (DPO), and their net value, cash conversion cycle (CCC). These are commonly-used measures of firms' working capital efficiency in both academia (e.g. Dechow, 1994; Subramanyam and Wild, 2009) and practice (CFO Magazine, 2016). For example, *CFO Magazine* annually surveys the firms in 35 industries and rank 1,000 firms based on their CCC, DSO, DIO, and DPO. Reductions in DSO and DIO are commonly considered an improvement, while reduction in DPO is considered a deterioration in efficiency. Therefore, a reduction in the net measure, CCC (= DSO + DIO – DPO), represents an aggregate improvement for firm's efficiency in cash cycle. I thus investigate whether the working capital efficiency of an average U.S. firm has improved over time as measured by CCC. Following Dechow (1994), I define DSO, DIO, DPO, and CCC as the following:

$$\text{Days Sales Outstanding (DSO)} = \frac{(AR_t + AR_{t-1})/2}{Sales/360},$$

$$\text{Days Inventories Outstanding (DIO)} = \frac{(Inv_t + Inv_{t-1})/2}{COGS/360},$$

$$\text{Days Payables Outstanding (DPO)} = \frac{(AP_t + AP_{t-1})/2}{Purchase/360},$$

$$\text{Cash Conversion Cycle (CCC)} = \text{DSO + DIO – DPO} \qquad (1)$$

where AR is accounts receivables (Compustat RECT), Inv is inventory (Compustat INVT), AP is accounts payables (Compustat AP), COGS is cost of goods sold (Compustat COGS), and Purchase is defined as Compustat item $INVT_t – INVT_{t-1} + COGS_t$.

[Insert Table 2 Here]

Panel A of Table 2 shows the annual mean value of CCC, DSO, DIO and DPO over the period 1970-2017. For brevity, I average the annual mean value by 10 years intervals. Column 1 shows that the annual mean value of CCC has declined by approximately 30% over the past five decades. During the 1960s, it took approximately 105.3 days for average U.S. firms to convert cash into short-term investments, make sales, and collect back cash from customers. In the 2010s, the same process takes only 64.2 days for average U.S. firms. The time-trend coefficient estimate is –1.16 with t-statistics of -18.86 and adjusted R^2 of 0.88, which is an annual decline in cash cycle by, on average, 1.2 days per year. Columns 2, 3, and 4 show the annual mean value of DSO, DIO and DPO, respectively, by 10 years intervals. The annual mean values for DIO has sharply declined from 89.0 days in the 1970s to 63.4 days in the 2010s, while there is no deterministic trend for DSO. On the other hand, DPO has increased from 38.4 days in the 1960s to 59.2 days in the 2010s. The time trends for DIO and DPO are statistically significant with p-value less than 0.001. These trends show that improvement in inventory management and delaying cash payments (i.e., obtaining favorable vendor financing) have contributed to the aggregate decline in days to convert cash (CCC). I also repeat the analyses using the annual median value and the results are almost identical. To summarize, I find that both mean and median value of CCC have sharply declined over the past half a century, and that this net reduction is predominantly due to a reduction in DIO and an increase in DPO. These results are consistent with the prior expectation that the development in information technology precipitates a more efficient management of working capital at U.S. firms. Panel B plots the annual mean and median value of CCC over the sample period. Panel C and D plots the annual mean (Panel C) and median (Panel D) value of DSO, DIO, and DPO.

2-3) Alternative Explanations

Despite a strong time trends observed in Section 2-2, it is premature to make a conclusion because there are potentially alternative explanations towards the time trend. First, I examine whether there exists any differences in the observed temporal trends across different industries. For example, firms in service industries are likely to have smaller cash conversion cycle than firms in manufacturing or trading industries. Given that U.S. economy has shifted from manufacturing to a knowledge-based one over the past half a century (Srivastava, 2014), it is possible that a surge in service industries contribute to the decline in the aggregate cash conversion cycle over time. Therefore, I repeat the preceding analyses by sub-samples based on Fama-French 10 industry classification. Detailed industry definition is provided in Appendix B.

[Insert Table 3 Here]

Panel A of Table 3 provides annual mean value of CCC from 1964 to 2016 by Fama-French 10 industry classification. Throughout columns 1 to 10, I find strong declines in the annual mean value of CCC for all Fama-French 10 industries. For example, the annual mean value of CCC declines in both consumer non-durable (column 1) and durable goods (column 2) industries from 114.0 and 126.9 days in the 1970s to 87.2 and 86.6 days in the 2010s, respectively. The most significant decline is observed in the business equipment industry (column 5), where the annual mean value of CCC declines from 160.6 days in the 1970s to 60.8 days in the 2010s. This trend translates to an annual decline of CCC by approximately 2.9 days. The utilities industry (column 9) industry is characterized with the least significant decline. The annual mean value of CCC declines from 36.5 days in the 1970s to 27.5 days in the 2010. Although the economic magnitude of decline is smaller than the other industries, both t-statistics (-6.07) and R^2 (0.43) of the time-trend regression is fairly strong. These result show that the decline is CCC is not concentrated in a specific sub-set of industry but rather a systematic phenomenon across all industries. Therefore, industry membership does not fully explain the intertemporal decline in CCC over time. Panel B plots their trends over time.

Second, Fama and French (2004) argue that characteristics of firms listed after 1980 are fundamentally different from those that existed before. Specifically, in the annual cross-section of all firms listed in the U.S. stock markets, they show that the profitability of new list firms drift down in the left tail and that growth becomes more right skewed. Similarly, Srivastava (2014) reports that changes in sample firm composition over the period 1970-2009 contribute to changes in earnings quality over time. Moreover, if the change in sample composition is correlated with industry membership, it is possible that newly emerging service firms may contribute to the intertemporal trends in CCC. Therefore, it is possible that the observed decline in the CCC is attributable to change in sample firm composition over the past 5 decades.

[Insert Table 4 Here]

Panel A of Table 4 investigates the extent to which changes in sample composition affect the observed trends in CCC. Despite concerns for survivorship bias, one way to account for the change in sample composition is to hold sample firms constant over time. Therefore, I first look at intertemporal trends using only the 278 firms surviving continuously over the sample period from 1970 to 2017. Column 1 in Panel A of Table 4 provides intertemporal trends in the annual mean value of CCC of the 278 surviving firms. Similar to the aggregate trends, the annual mean value of CCC at surviving firms declines from around 108.8 days in the 1960s to 76.9% in the 2010s. The coefficient estimate from time-trends estimate is -0.86 and significant with a t-statistic of -19.13 and the adjusted R^2 of 88.6%. This surviving firm results show that the overall decline in CCC is not attributable to a change in sample firm composition over time. Another way to examine the effect of sample composition change is to analyze samples based on groups of cohort firms. Specifically, I assign firms into different cohort groups based on their first year of appearance in Compustat database. For example, firms that first appear in the database before the year 1970 is assigned a cohort group “<1970s firms”, firms that first appear in the database from 1970 to 1979 is assigned a cohort group "1970s firms", and so on. Columns 2 through 6 of Panel A reports the annual mean value of CCC by different cohort groups. Column 2, 3, and 4 show that groups of firms in <1970s, 1970s, and 1980s cohorts experience significant decline in their CCC by average -0.86 days per year. Specifically, firms in <1970s, 1970s, and 1980 cohorts reduce their CCC from 94.0 days, 101.3 days and 89.1 days in the 1980s, respectively, to 68.4 days, 71.3 days, and 80.4 days in the 2010s. On the other hand, note that firms appearing in the sample post-1990s do not exhibit declining time-trends. Rather, they increase their CCC over time, which affects *against* the overall declining time-trend in CCC. However, note that their CCC is already low when compared to the older firms (e.g., <1970s, 1970s, and 1980s cohort firms). This is consistent with prior research in firm life cycle (Quinn and Cameron, 1983; Dickinson, 2011; Hribar and Yehuda, 2015) where the firms in introduction or growth stage make significant investments in short-term operating assets. At the same time, the very fact that the newly emerging firms appear in the sample with already-low-level of CCC suggests that CCC is affected by macroeconomic forces that shape the working capital management technology at average firms. Together, these evidence suggest that the newly emerging firms contribute to the overall lower level of CCC, but cannot explain the declining time-trends in CCC. Panel B and C plots the annual mean value of CCC for 278 surviving firms (Panel B) and by different cohort groups (Panel C).

Third, I examine whether the opportunistic earnings management affects CCC over time. For example, both accruals-based earnings management (Healy, 1985; McNicnols and Wilson, 1988) or real activities manipulation (Roychowdhury, 2006) can potentially deviate CCC from its optimal level. For example, a manager can make a choice with respect to the provisioning of bad debt to influence the amount of accounts receivables reported (McNichols and Wilson, 1988). A manager may also engage in sales manipulation, in which case accounts receivables increases given the same level of sales, thereby increasing DSO. Similarly, a manager may over-produce or over-purchase to reduce cost of goods sold and inflate earnings (Roychowdhury, 2006). In this case, both DIO and DPO will be affected. However, it is noteworthy that any accruals-based or real activities manipulation in one period must reverse in another period (Baber, Kang, and Li, 2011; Dechow, Hutton, Kim, and Sloan, 2012; Larson, Sloan, Zha Giedt, 2018). Therefore, it is unlikely that such an opportunistic accounting treatment reflects a long-run trends in CCC over the five decades. Nevertheless, I repeat the analysis by examining firm-by-firm 5-year rolling average value of CCC. Any opportunistic components should reverse over the selected time period[8].

[Insert Table 5 Here]

Panel A of Table 5 shows the annual mean value of CCC, DSO, DIO and DPO over the period 1970-2017. DSO, DIO and DPO are calculated by obtaining the value of their respective components as firm-by-firm 5-years rolling average. Column 1 shows that the annual mean value of CCC on 5-year rolling basis has declined from around 102.6 days in the 1960s to 60.3 days in the 2010s. The time-trend coefficient estimate is –1.00 with t-statistics of -6.37 and adjusted R^2 of 0.46. Columns 2, 3, and 4 show the annual mean value of DSO, DIO and DPO on 5-year rolling basis, respectively. The annual mean values for DIO has sharply declined from 89.2 days in the 1970s to 61.9 days in the 2010s, while there is no deterministic trend for DSO. DPO has increased from 44.6 days in the 1960s to 57.8 days in the 2010s. The time trends for DIO and DPO are statistically significant with p-value less than 0.001. These trends show that opportunistic accounting treatment does not affect the long-run decline in CCC at U.S. listed firms. Panel B and C plots the 5-years rolling value of CCC (Panel B) and DSO, DIO, and DPO (Panel C) over time.

2-4) Regression Analysis

The preceding analyses offer a few insights. First, the intertemporal decline in CCC is systematic across almost all subset of firms delineated by age or industry groups. Second, the decline is not explained by opportunistic earnings management. While these evidence rule out some important alternative explanations, it might yet be circumstantial to conclude that the development in information technology has had the deterministic impact on the efficiency of working capital management of U.S. firms over the past five decades. Therefore, in this section, I directly test whether the development in information technology

[8] For example, Dechow, Hutton, Kim and Sloan (2012) models the reversal period to be 3 years. Larson, Sloan and Zha Giedt (2018) models the reversal period to be 5 years.

is associated with the decline in CCC by exploiting an exogenous proxy representing the development in information technology over time.

Since 2003, the Census Bureau annually surveys (ICTS; Information & Communication Technology Survey) all companies with at least 500 paid employees about their business spending for information and communication technology (ICT) equipment and computer software. The Census Bureau annually reports the total spending on ICT by 2-digit NAICS industry. It is a useful proxy because it directly measures the development in information technology while seems unlikely to affect firms' cash conversion cycle directly. Specifically, I estimate the following OLS regression to estimate the effect of information technology on CCC[9]:

$$CCC_{i,t} = \alpha_0 + \alpha_1 \cdot Time_t + \alpha_2 \cdot IT\_Spending_{m,t} + \sum \alpha_k \cdot Controls_{i,t} + \varepsilon_{i,t} \quad (2)$$

where $CCC_{i,t}$ is firms' cash conversion cycle as defined in equation (1); $Time_t$ is the number of years since 1970; and $IT\_Spending_{m,t}$ is defined as the percentage increase in ICT spending as provided by the Census Bureau. I include SIC 2-digit industry fixed effect and cohort fixed effect to control for the effect of industry membership and sample firm composition. Control variables include *Log_AUDIT*, *DTR2*, *Loss*, *Interest_Cover*, *Ln_SIZE*, and *Growth*. *Log_AUDIT* is defined as the natural logarithm of hierarchical audit opinion variable[10] and controls for the effect of opportunistic accounting practice. *DTR2* is the adjusted R^2 from annual cross-sectional estimation of Dichev and Tang (2008) model and controls for the possibility that better matching resulting in increased cash flows. *Loss* is an indicator variable that equals to 1 if income before extraordinary items (Compustat IB) is negative, and zero otherwise. *Interest_Cover* is defined as interest expense (Compustat XINT) divided by income before extraordinary items (Compustat IB). Both *Loss* and *Interest_Cover* are included as control variables because financially constrained firms may have deteriorated cash conversion cycle. *Ln_SIZE* is defined as the natural logarithm of total assets and included

[9] Although the use of Census Information & Communication Technology Survey (ICTS) limits the available sample year, it is the best available proxy yet known.
[10] 1, 2, 3, 4, and 5 each represents unqualified, qualified, no opinion, unqualified with additional language, and adverse opinion, respectively. I exclude 0 which is unaudited.

to control for the scale economy in cash conversion cycle. Lastly, *Growth* is defined as market-to-book ratio (Compustat CSHO*PRCC_F/CEQ) and controls for the effect of life-cycle or growth firms effects.

[Insert Table 6 Here]

Table 6 provides the results of OLS regression (2). Column 1 shows that CCC has decreased by approximately 0.01 days per year during the sample period. Column 2 shows that *IT_Spending* is significantly and negatively associated with *CCC,* suggesting that the development in information technology decreases cash conversion cycle. In column 3, I include both *Time* and *IT_Spending*, where *Time* is no longer significant while *IT_Spending* continues to be statistically significant and negative. In column 4, I include all fixed effects and control variables and cluster standard errors by firm. Again, *IT_Spending* is statistically significant and negative. The coefficient estimate on *IT_Spending* is -16.96 after controls, suggesting that 1% increase in ITC spending is associated with a reduction of CCC by approximately 0.17 days. The results suggest that the development in information technology has a deterministic effect on U.S. firm's working capital management and the effect is incremental to potential alternative explanations. In column 5, I repeat the analysis by first-differencing each variables. The results are weaker but shows that the change in IT spending is significantly associated with the change in CCC over time.

3. Implications for Accounting Research

3-1) Impact on Asset Structure

Next, I investigate how these real economic changes in information technology and the cash conversion cycle impact the firms' asset structure. Holding the cost of goods sold constant, a decrease in DIO directly decreases inventory, a component of current operating assets. Likewise, holding purchase volume constant, an increase in DPO directly increases accounts payable, a component of current operating liabilities. Together, the net impact provides two testable hypotheses. First, a reduction in cash conversion cycle is likely to decrease liquidity ratios, defined as current operating assets divided by current operating liabilities. Hence, a firm with precautionary motive is likely to accumulate more cash balance given the costly external capital market (Opler, Pinkowitz, Stulz, and Williams, 1999; Almeida, Campello and Weisbach, 2004; Bates, Kahle and Stulz, 2009). Therefore, I hypothesize that firms increase cash holdings due to a real improvement in the efficiency of working capital management. Second, I expect the *net* working capital balance, defined as the current operating assets less current operating liabilities, to decrease over time. For example, Dechow (1994) predicts that firms with shorter operating cycles are expected to have smaller working capital requirements. Hence, the intertemporal reduction in CCC potentially reduces the net working capital balance over time. Although these two hypotheses may seem obvious, they may not necessarily hold if a reduction DIO is precipitated by an increase in cost of goods sold, or if an increase in DPO is precipitated by a decrease in purchase volume. Moreover, there are alternative motives (e.g., transaction motive, tax motive, or agency motive) for firms to hold cash other than the expected precautionary motive.

[Insert Table 7 Here]

Panel A of Table 7 provides the annual mean value of cash balance (column 1), current operating asset balance (column 2), current operating liabilities balance (column 3), net working capital balance (column 4), liquidity ratio excluding cash (column 5), and liquidity ratio including cash (column 6). Column 1 shows that the annual mean value of cash balance has sharply increased from 4.2% of average total assets in the 1970s to 17.6% in the 2010s. That is an increase of cash by 0.4% of total assets every year from 1970 to 2017. On the other hand, column 2 indicates that the annual mean value of net working capital balance has sharply decreased from 28.9% of average total assets in the 1970s to only 6.5% in the 2010s, which is an annual decline of 0.6% of total assets. Moreover, columns 3 and 4 indicate that the decline in net working capital balance is mostly attributable to a decline in current operating assets. The annual mean value of current operating assets (column 3) decreases from 49.4% of average total assets in the 1970s to 27.4% in the 2010s. On the other hand, the annual mean value of current operating liabilities (column 4) does not show any trends between the year 1970 to 2017. Together, these evidence indicate that there has been a significant structural shift in the asset structure of average U.S. firms. The net working capital balance has almost disappeared from the balance sheet as it accounts for only less than 5% of total assets in the year

2017. On the other hand, cash holding has significantly increased to over 16% of total assets in the year 2017. Panel B and C plots the intertemporal trends of cash and net working capital (Panel B) and current operating assets and current operating liabilities (Panel C) over time.

Cash holding of U.S. firms has been widely criticized by media and politician recently. For example, Forbes article *Tax Multinationals' Excess Cash* argues that "companies are sitting on wads of cash that is largely held in US accounts" and therefore "we should tax it away from them". It is also argued that the foreign repatriation tax is the major reason why corporates hold onto cash, and popular media tends to urge for a tax reform to "encourage U.S. companies to move foreign income back home" (*Apple's Case for Tax Reform*; New York Time, 2017). However, it should be noted that a reduction in current operating assets, holding current operating liabilities constant, deteriorates the liquidity ratio over time. Hence, it is entirely possible that the increase in cash balance at U.S. firms is precipitated by the systematic shift in information technology and the efficiency of working capital management. Columns 5 and 6 of Panel A, Table 7, shows the intertemporal trends in the liquidity ratio over time. *Excluding* the cash balance, the annual mean value of liquidity ratio (column 5) continues to decline over the period 1970-2017, from around 2.63 in the 1970s to 1.56 in the 2010s. However, column 6 indicates that the annual mean value of liquidity ratio, *including* cash, is fairly constant throughout the sample period between 2.5 to 3.0. These provide a preliminary evidence that the corporation's first order consideration in determining the cash balance may simply be their liquidity concerns.

Hence, I formally test whether the precautionary motive (e.g., concerns for deteriorating liquidity ratio) has the first order effect on the cash holding of U.S. firms after controlling for potential alternative explanations, including the transaction motive (Miller and Orr, 1966), tax motive (Foley, Hartzell, Titman and Twite, 2007; Hanlon, Lester and Verdi, 2015; Gu, 2017), and agency motive (Jensen, 1986). Specifically, I estimate the following regression:

$$Cash_{i,t} = \beta_0 + \beta_1 \cdot Liquidity_{i,t} + \beta_2 \cdot VolCFO_{i,t} + \beta_3 \cdot Capex_{i,t} + \beta_4 \cdot R\&D_{i,t} + \beta_5 \cdot Size_{i,t} + \beta_6 \cdot \%Foreign_{i,t} + \beta_7 \cdot Dividend_{i,t} + \varepsilon_{i,t} \quad (3)$$

where $Cash_{i,t}$ is cash divided by average total assets; and $Liquidity_{i,t}$ is liquidity ratio defined as the current operating assets divided by current operating liabilities. I expect to find significant and negative β_1 coefficient estimate to show that the liquidity concern arising from the real improvement in working capital management has the first order effect on the cash balance of U.S. firms. This is also consistent with Bates, Kahle, and Stulz (2009) who show that precautionary motive has the first order impact on firms' cash balance. Specifically, they show that firms with smaller inventory, greater cash flow risk, smaller capital expenditure, and greater R&D expenditure has greater cash balance. Consistently, I include $VolCFO_{i,t}$, defined as the trailing 5 year standard deviation of operating cash flows divided by average total assets, to control for cash flow risk of firm. I also include $Capex_{i,t}$, defined as capital expenditure divided by average total assets, and $R\&D_{i,t}$, defined as research and development expenditure divided by average total assets, as control variables. Moreover, I control for transaction motive by including $Size_{i,t}$, defined as the natural logarithm of total assets, as a control variable because there is economies of scale with the transaction motive (Mulligan, 1997). If transaction motive is strong, I expect to find significant and negative β_5 coefficient, since larger firms have greater scale economy and therefore is less likely to hold cash. I also control for tax motive by controlling for $\%Foreign_{i,t}$, defined as the absolute value of foreign exchange income (loss) divided by average total assets. If repatriation tax concern is the reason why U.S. corporates hold cash balance, then I would expect to find significant and positive β_6 coefficients. $Dividend_{i,t}$ is the dividend payout ratio and is defined as the sum of ordinary and preferred dividend and stock repurchases divided by income before extraordinary items. According to Jensen (1986), entrenched managers are more likely to hold cash than to pay dividends to shareholders. Therefore, I would find negative and positive β_7 coefficient is agency motive is the reason why U.S. firms hold increasingly large amount of cash. Lastly, I include $Growth_{i,t}$ and $Leverage_{i,t}$ to control for the possibility that growth firms require more cash balance and that highly levered firms has higher external cost of capital. $Growth_{i,t}$ is defined as the market-to-book ratio and $Leverage_{i,t}$ is defined as the interest-bearing debt divided by average total assets.

[Insert Table 8 Here]

Table 8 provides the regression result of equation (3). Columns 1-3 provide the regression of the level of cash balance on various determinants of cash holdings. In columns 4-6, both dependent variable and independent variables are change variables. Throughout all columns, I find that liquidity (change in liquidity) is significantly and negatively associated with cash balance (change in cash balance), after controlling for potential alternative motivations to hold cash. *VolCFO* (Δ*VolCFO*) is also positively associated with *Cash* (Δ*Cash*), showing the firms tend to hold more cash when they are faced with more volatile operating environment. *Capex* (Δ*Capex*) is also negatively associated with *Cash* (Δ*Cash*), showing that firms with real investment needs spend cash on them. These results are consistent with the precautionary motive of cash holding (Bates, Kahle and Stulz, 2009). However, *RD* is positively associated with *Cash*, while Δ*RD* is negatively associated with Δ*Cash*. The result for transaction motive is also not clear since *Size* is negatively associated with *Cash*, but Δ*Size* is positively associated with Δ*Cash*. Tax motive is also not clear. *Foreign* is positively associated with *Cash*, but Δ*Foreign* is not associated with Δ*Cash*. This is in sharp contrast with a recent stream of literature arguing that repatriation tax has the first order impact on corporate cash holdings. In untabulated result, I also examine whether the cash balance increase during the period 1970-2017 for firms with no foreign operations. I find that the cash balance also increase significantly from 4.3% of average total assets in the 1970s to 17.4% in the 2010s for firms with no foreign operations. Moreover, the time-trends are statistically insignificant between firm with foreign operations and without foreign operations. Together, these evidence show that the effect of foreign repatriation tax is at least not the first order concern to corporations in holding greater cash balance over time. Lastly, *Dividend* (Δ*Dividend*) is negatively associated with *Cash* (Δ*Cash*), showing that agency motive also has some effect on corporate cash balance. *Growth* (Δ*Growth*) is positively associated with *Cash* (Δ*Cash*) and *Leverage* (Δ*Leverage*) is negatively associated with *Cash* (Δ*Cash*).

To summarize, there has been a structural shift in the asset structure of U.S. firms precipitated by a real development in information technology and the efficiency of working capital management. To elaborate, the development in information technology has reduced the cash conversion cycle of U.S. firms by average 1.16 days per year, which has subsequently decreased the net working capital balance by 0.6%

of total assets per year and increased the cash balance by 0.4% per year. The overall decline in the net working capital balance is sustained by a decline in current operating assets but not by an increase in current operating liabilities. The increase in cash balance is primarily due to increased liquidity concern, and is significant after controlling for potential alternative motives of holding cash. Together, these changes have led the average U.S. firms to have less than 5% of net working capital balance on their balance sheet by the year 2017.

3-2) Change in Working Capital Accruals

A distinct feature of accruals accounting is that the income statement and the balance sheet articulate under clean surplus accounting (e.g. Barton and Simko, 2002; Baber, Kang, and Li, 2011). That is, any changes in the working capital accounts on the balance sheet precipitate corresponding changes in accruals on the income statement, and vice versa. For example, the adoption of JIT technology reduces the amount of inventory on firms' balance sheet, which subsequently affects accruals on the income statement (e.g. working capital *accruals*$_t$ ≡ change in working capital$_t$ ≡ working capital$_t$ – working capital$_{t-1}$). Therefore, I expect to find corresponding changes in working capital *accruals* over time, contemporaneously with the change in net working capital balance.

[Insert Table 9 Here]

Panel A of Table 9 shows the intertemporal trends in working capital *accruals* (ΔWC) divided by either average total assets (column 1), earnings (column 2), change in sales (column 3), or change in expenses (column 4). I explore the inter-temporal trends in working capital *accruals* not only as a proportion of total assets on the balance sheet, but also as a component of earnings on the income statement, because accounting literature typically models accruals as some proportion of operating activities during the accounting period. For example, accounting literature typically models accruals as a function of change in sales and expenses. Dechow, Kothari, and Watts (1998) model accounts receivables as a proportion α of sales, accounts payables as a proportion β of purchases which is determined in part by sales, and inventory as a proportion γ of expected sales. Similarly, Jones (1991) models accruals as a function of change in sales such that $\text{Accruals}_t = \alpha \cdot \Delta\text{Sales}_t + \beta \cdot \text{PPE}_t + \varepsilon_t$. Therefore, a potential alternative explanation towards declining working capital accruals is that it has declined in proportion to the decline in sales change. For example, Klein and Marquardt (2006) show that the real performance of U.S. firms has significantly declined over a past 50-year period. Therefore, it is possible that declining firm performance as measured by sales contribute to the intertemporal decline in working capital accruals.

Column 1 of Panel A, Table 9, shows that the working capital accruals as a proportion of total assets has sharply declined from 3.0% of average total assets in the 1970s to 0.3% in the 2010s. Moreover, the working capital accruals also decline as a proportion of earnings, from 18.8% in the 1970s to only 5.4% in the 2010s (Column 2). Columns 3 and 4 further show that the working capital accruals has also declined from 18.3% of change in sales and 17.7% of change in expenses in the 1970s to 3.6% of change in sales and 6.7% of change in expenses in the 2010s. That is, the observed decline in working capital accruals is not explained by accruals' proportionate change to change in sales or expenses, as is commonly modeled in accounting literature (i.e., the 'normal' accruals-generating-process). These trends suggest a significant shift in the accruals-generating-process over time.

3-3) Relationship between Earnings and Cash Flows

The observed intertemporal decline in working capital accruals also implies intertemporal changes in the relationship between earnings and cash flows. Observe that working capital accruals account for only 5.4% of operating income in the 2010s, suggesting that some 95% of operating income is cash-based earnings in recent periods. Because earnings equal the sum of accruals and cash flows, a reduction in the magnitude of working capital accruals implies a narrowing difference between operating income and operating cash flows, which, in turn, leads to a higher correlation between operating income and operating cash flows. Note that practitioners typically consider high correlations between earnings and cash flows as an indication of high-quality earnings (Dichev, Graham, Harvey and Rajgopal, 2003).[11] From this

[11] Anecdotal evidence suggests similar perception. For example, 2018 CFA Program Level II Curriculum Book writes that "the analysts' most pressing concerns include the following: Are Nestle's operating earnings backed by

perspective, the increasing earnings-cash flow correlation may indicate that earnings quality has been increasing over the last 53 years. However, extant accounting literature document the contrary such that earnings quality has declined over the past five decades due to increase in intangible-intensive industry (Collins, Maydew, and Weiss, 1997), changes in Generally Accepted Accounting Principle (GAAP) (Donelson, Jennings, and McInnis, 2011), poor matching between revenue and expense (Dichev and Tang, 2008), and changes in sample firm composition (Srivastava, 2014).

Therefore, I investigate whether the declining accruals is attributable to increase in earnings-cash flows cash flows correlation. First, I algebraically decompose the earnings-cash flows correlation to understand its underlying components. Let “E”, “CFO”, “Accr” and “a” denote operating income, operating cash flows, working capital accruals and accruals-to-earnings ratio, respectively. Then, I denote working capital accruals and operating cash flows as “a” and “1–a” percent of operating income[12], respectively, since operating income equals the sum of working capital accruals and operating cash flows (E ≡ Accr + CFO). Next, I re-write the correlation between operating income and operating cash flows as follows:

$$Corr(E, CFO) = \frac{Cov(E,CFO)}{Std(E)*Std(CFO)} = \frac{Cov(E,(1-a)*E)}{Std(E)*Std(CFO)} \tag{2}$$

Supposing that “a” and “E” are both random variables, the numerator can be written as:

$$\begin{aligned} Cov\left(\tilde{E}, (1-\tilde{a})*\tilde{E}\right) &= Cov\left(\tilde{E},\tilde{E}\right) - Cov\left(\tilde{E},\tilde{a}*\tilde{E}\right) \\ &= Var\left(\tilde{E}\right) - Cov\left(\tilde{E},\tilde{a}*\tilde{E}\right) \\ &= Var\left(\tilde{E}\right) - [E(\tilde{a})*E\left(\tilde{E}^2\right) - E(\tilde{a})*\left\{E\left(\tilde{E}^2\right)\right\}^2] \\ &= Var\left(\tilde{E}\right) - E(\tilde{a})*Var(\tilde{E}) \\ &= \{1-E(\tilde{a})\}*Var(\tilde{E}) \end{aligned} \tag{3}$$

Replacing the numerator in equation (2) with equation (3) and simplifying the expectation term, I can re-write earnings-cash flows correlation as:

$$Corr(E, CFO) = \frac{(1-a)*Var(E)}{Std(E)*Std(CFO)} = (1-a)*\frac{Std(E)}{Std(CFO)} \tag{4}$$

[12] That is, Accr ≡ a*E and CFO ≡ (1-a)*E, respectively.

Two points are worth noting from equation (4). First, Corr(E, CFO) is a function of (i) the accruals-to-earnings ratio "a" and (ii) standard deviation of operating income relative to that of operating cash flows ($\frac{Std(E)}{Std(CFO)}$). Second, by taking derivative[13] with respect to "a", Corr(E, CFO) strictly decreases (increases) with increases (decreases) in "a"[14]. In other words, a decrease in accruals portion of operating income strictly increases the correlations between operating income and operating cash flows. The intuition behind algebraic result is simple, because operating income and operating cash flows are more correlated when the distance between the two is smaller.

[Insert Table 10 Here]

Then, I explore whether the correlation between earnings and cash flows has indeed increased over time, because a number of simplifying assumptions[15] in the preceding algebra may not hold in our sample firms. Column 1 (column 2) of Panel A of Table 10 presents intertemporal trends in Pearson (Spearman) earnings-cash flows correlations. Consistent with the expectation, the correlation between operating income and operating cash flows has risen from 0.679 in the 1960s to 0.885 in the 2010s. The increase is also statistically significant with a coefficient estimate of 0.01, t-statistics of 15.54 and the R^2 of 0.82. In an untabulated results, I also regress *Corr(E, CFO)* on accruals-to-earnings ratio "a" to test the proposition that the decrease in working capital accruals contribute to the increase in earnings-cash flows correlation over time. The results indicate that one percent reduction in accruals-to-earnings ratio "a" is associated with an increase in Pearson (Spearman) correlation between earnings and cash flows by 0.102 (0.089). Together, these results indicate that the reduction in working capital accruals contribute to increasing correlation between operating income and cash flows. As noted before, practitioners typically consider high earnings-cash flows correlation as an indication of high earnings quality (Dichev et al., 2013). However, the results

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[13] $\frac{\partial \mathrm{Corr(E,CFO)}}{\partial \mathrm{a}} = -\frac{Std(E)}{Std(CFO)} < 0$, since Std(E) > 0 and Std(CFO) > 0.

[14] A third point to note is that increase (decrease) in $\frac{Std(E)}{Std(CFO)}$ strictly increases (decreases) earnings-cash flows correlation as long as 0 < a < 1. However, the extent to which $\frac{Std(E)}{Std(CFO)}$ increase or decrease earnings-cash flows correlation is beyond the scope of this paper and is studied extensively by a concurrent paper Kang and Na (2018).

[15] For example, I assume that 0 < a < 1 and that $E(\tilde{a})$=a.

show that the recent increase in earnings-cash flows correlation is an outcome of the declining working capital accruals and is not a *de facto* indicator for higher earnings quality. Stated differently, the apparent increase in earnings quality may not have come from an improvement in financial reporting, but from real improvement in efficiency in working capital management. If any, the increase in earnings-cash flows correlation rather indicates that *cash flows* (vis-à-vis earnings) has become a relatively better measure of firm performance (e.g., became closer to earnings) over time (e.g., Dechow, 1994).

4. Conclusion and Discussion

In this paper, I postulate that the evolution in information technology over the past five decades precipitate more efficient working capital management at average U.S. firms in the period 1970-2016. Consistent with this expectation, I document that the cash conversion cycle, levels of working capital accounts on the balance sheet, and their size relative to the income statement (e.g., working capital accruals) have all declined significantly over the past five decades. Specifically, the annual mean value of cash conversion cycle has declined from 105.3 days in the 1970s to 64.2 days in the 2010s. The decline is unexplained by the change in sample firm composition, industry membership, or earnings management over time. Moreover, I find that the reduction in cash conversion cycle can be explained by a development in information technology, as proxied by the IT spending data provided from the U.S. Census bureau. Consistent with the decline in cash conversion cycle, the annual mean value of net working capital *balance* and working capital *accruals* have all decline from 28.9% and 3.0% of average total assets in the 1970s to around 6.5% and 0.3% of average total assets in the 2010s, respectively. That is, the overall U.S. firms have become a more efficient manager of working capital over the past five decades.

I also highlight that these changes have potentially important implications to accounting research. First, the intertemporal shift in the efficiency of working capital management has changed the asset structure at most U.S. firms. A reduction in the net working capital balance lowers the liquidity ratio at U.S. firms, and thereby creates a precautionary motives to hold increasing amount of cash balance. Consistently, the cash balance at average U.S. firms has increased from only 4.2% of average total assets in the 1970s to almost 17.6% in the 2010s. I also test that this liquidity concern has the first order impact on the cash balance of U.S. firms after controlling for potential alternative explanations. Most notably, the cash balance at U.S. firms increase regardless of whether the firm has foreign operations or not. The results indicate that the repatriation tax may not necessarily have the prevailing impact on the cash balance at U.S. firms. Rather, the real improvement in information technology seems to be the reason why U.S. firms need more cash balance in a more recent period.

I conclude this paper with the following discussions and suggest some future research avenue. First, reduction in the size of accruals implies less ability to manage earnings using accruals. If the level of net working capital on the balance sheet is a limit to which accruals-based earnings management is constrained (e.g. Barton and Simko, 2002; Baber, Kang and Li, 2011), the reduction in the level of net working capital balance indicates a reduction in the *ability* to manage earnings via accruals. Therefore, an interesting question is whether the small magnitude of accruals affects accruals-based earnings management. Follow-up research can answer whether this leads to a more transparent financial reporting regime in more recent periods or simply a substitution among accruals-based earnings management, real earnings management, cash flows management, classification shifting, and/or others.

Second, the observed intertemporal decline in accruals also makes us reconsider the role of accruals accounting. It is well known that accruals convey information about expected future cash flows, and for that reason, is a superior measure of firm performance than cash flows (Ball and Brown, 1968; Rayburn, 1986; Dechow, 1994). Accruals also contain private information and expectation of managers about future cash flows (e.g., Subramanyam, 1996; Bradshaw, Richardson, and Sloan, 2001; Louis and Robinson, 2005). From such a viewpoint, the intertemporal decline in accruals is important for two reasons. First, information technology and efficiency gain have reduced informational uncertainty for managers and accountants. With lower inventory level and faster collection cycle, there is reduced needs to make assumptions and forecasts and thus a reduced amount of private information contained in earnings incremental to operating cash flows (i.e., accruals). Therefore, an interesting future research may address whether the informational role of accruals earnings is reduced in the capital market in more recent periods.

Lastly, what would be the role of accrual accounting when information technology can (more) perfectly predict customer's credit risk, forecast bad debts, optimize inventory level, and determine precisely how much PPE was used to generate revenue, and so on? Will there be a room for accounting assumptions and judgment? For example, the reason accountants rely on either FIFO or LIFO assumption is because it is cost-inefficient for humans to track down individual inventory flows. Similarly, various depreciation methods are used because of our limited capacity to cost-efficiently measure the use of PPE for a given amount of sale. If true figures (e.g., the true amounts of inventory, cost of goods sold, assets used, etc.) can be revealed by the advanced information technology (e.g., artificial intelligence), will accrual accounting still remain useful information technology? Will managers be able to manipulate earnings? Do we need auditors or data inspectors? Shall we continue to teach our students debits and credits? These are, of course, hypothetical questions. However, these technological changes are not forthcoming; they are already here, and the disappearing working capital is just one facet of it. I believe that these questions merit the attention of academics, educators, managers, auditors, investors and regulatory agencies to reconsider the role of accrual accounting as a form of information technology.

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Table 1. Sample Selection and Descriptive Statistics

Panel A of Table 1 explains sample selection process. Out of 409,7167 firm-year observations in the Compustat universe, I drop foreign firms (30,115), non-NYSE, AMEX, or NASDAQ firm (160,991), financial and public administration firms (60,212), and observations with missing variables to calculate CCC and working capital (24,421). My final sample consists of 133,977 firm-year observations between the year 1970 and 2017. Panel B shows descriptive statistics of main variables. CCC is defined following Dechow (1994). Working capital is defined as the difference between current operating assets and current operating liabilities, divided by average total assets, following Richardson, Sloan, Soliman and Tuna (2005). Earnings (E) is defined as operating income before depreciation divided by average total assets. Cash flow from operation (CFO) is defined as the difference between earnings and working capital.

Panel A. Sample Selection

	#Obs
All Compustat firm-year observations between 1970-2017	409,716
Drop foreign firms	30,115
Drop non-NYSE, AMEX, NASDAQ firms	160,991
Drop financial and public administration firms	60,212
Drop observations with missing core variables	24,421
Final firm-year observations	133,977

Panel B. Descriptive Statistics

Variables	N	Mean	StdDev	Median	1^{st} Pctl	99^{th} Pctl
CCC	133,977	79.6	101.5	69.6	-261.2	393.6
DSO	133,977	57.3	39.3	52.6	0.6	215.9
DIO	133,977	71.6	73.4	55.8	0.0	353.0
DPO	133,977	51.0	67.8	34.9	4.7	405.9
WC	133,977	0.16	0.21	0.13	-0.31	0.66
ΔWC	133,977	0.02	0.09	0.01	-0.24	0.29
E	133,820	0.10	0.20	0.13	-0.77	0.45
CFO	133,977	-0.01	0.20	0.03	-0.93	0.31

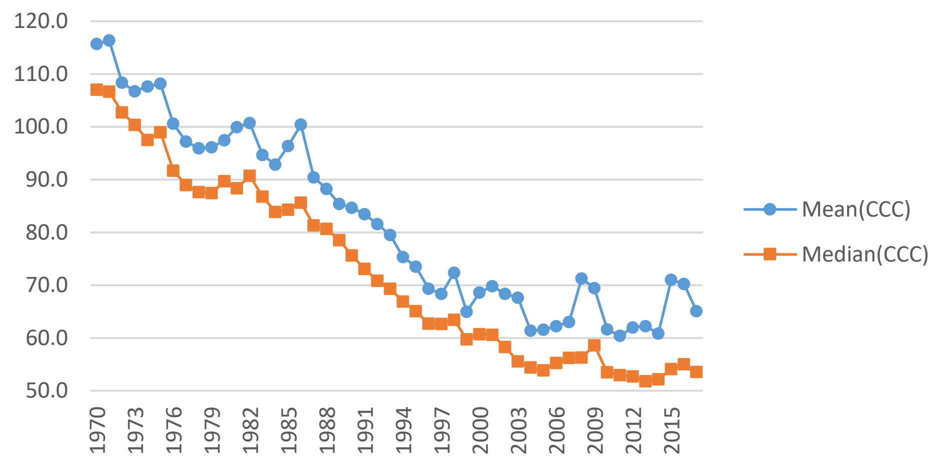
Table 2. Cash Conversion Cycle over Time (1970-2017)

Table 2 shows intertemporal trends in CCC, DSO, DIO and DPO over time. CCC is defined as DSO + DIO – DPO. DSO is defined as $\frac{(AR_t+AR_{t-1})/2}{Sales/360}$, DIO is defined as $\frac{(Inv_t+Inv_{t-1})/2}{COGS/360}$ and DPO is defined as $\frac{(AP_t+AP_{t-1})/2}{Purchase/360}$. Asterisks *, **, and *** denote two-tailed significance at the 10%, 5% and 1% levels, respectively.

Panel A. Mean CCC, DSO, DIO, and DPO over time

	CCC	DSO	DIO	DPO
1970s	105.3	54.0	89.0	38.4
1980s	94.7	60.3	82.0	48.2
1990s	75.3	58.9	67.4	52.2
2000s	66.3	56.0	62.3	54.3
2010s	64.2	56.4	63.4	59.2
Time Trends				
Coefficient	-1.16***	0.01	-0.75***	0.49***
(t-statistics)	*(-18.86)*	*(0.38)*	*(-15.00)*	*(12.27)*
R^2	0.88	-0.02	0.83	0.76

Panel B. Mean and Median CCC over time



Panel C. DSO, DIO, and DPO over time

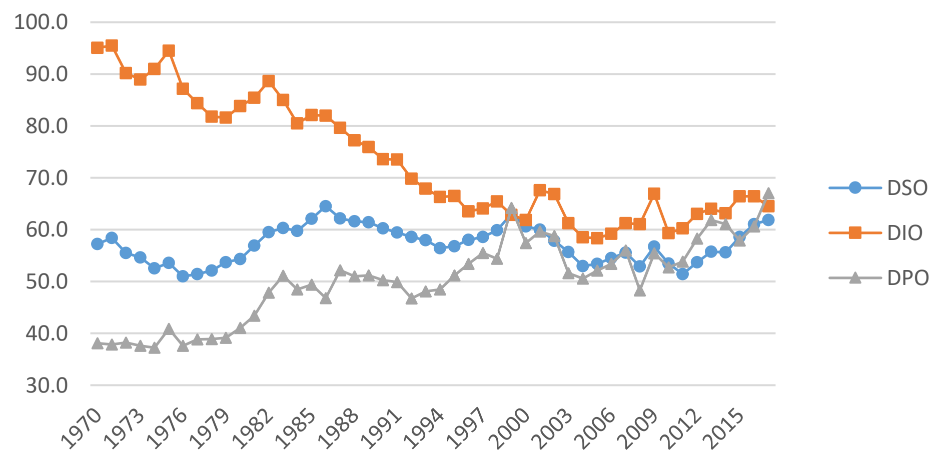


Table 3. Cash Conversion Cycle over Time by Fama-French 10 Industry (1970-2017)

Table 3 shows the intertemporal trends in CCC over time by Fama-French 10 industry. CCC is defined as DSO + DIO – DPO. DSO is defined as $\frac{(AR_t+AR_{t-1})/2}{Sales/360}$, DIO is defined as $\frac{(Inv_t+Inv_{t-1})/2}{COGS/360}$ and DPO is defined as $\frac{(AP_t+AP_{t-1})/2}{Purchase/360}$. Fama-French 10 industry classification is detailed in Appendix A. Asterisks *, **, and *** denote two-tailed significance at the 10%, 5% and 1% levels, respectively.

Panel A. Mean CCC over time by Fama-French 10 industry

	FF1	FF2	FF3	FF4	FF5	FF6	FF7	FF8	FF9	FF10
1970s	114.0	126.9	126.5	30.9	160.6	40.3	82.0	144.6	36.5	66.2
1980s	100.5	116.4	119.8	-17.6	149.5	29.2	70.9	134.6	34.9	60.3
1990s	103.0	102.7	108.0	-28.5	90.8	13.3	64.8	107.5	29.5	41.1
2000s	96.9	84.8	105.2	-45.1	68.3	15.7	55.6	101.9	25.9	33.3
2010s	87.2	86.6	105.8	-42.1	60.8	21.3	56.0	102.7	27.5	29.6
Time Trends										
Coefficient	-0.59***	-1.17***	-0.60***	-1.81***	-2.92***	-0.60***	-0.70***	-1.21***	-0.28***	-1.04***
(t-statistics)	*(-9.60)*	*(-17.24)*	*(-8.87)*	*(-6.84)*	*(-19.64)*	*(-6.01)*	*(-17.46)*	*(-11.53)*	*(-6.07)*	*(-20.17)*
R^2	0.66	0.86	0.62	0.49	0.89	0.43	0.87	0.74	0.43	0.90

Panel B.Mean CCC over time by Fama-French 10 industry

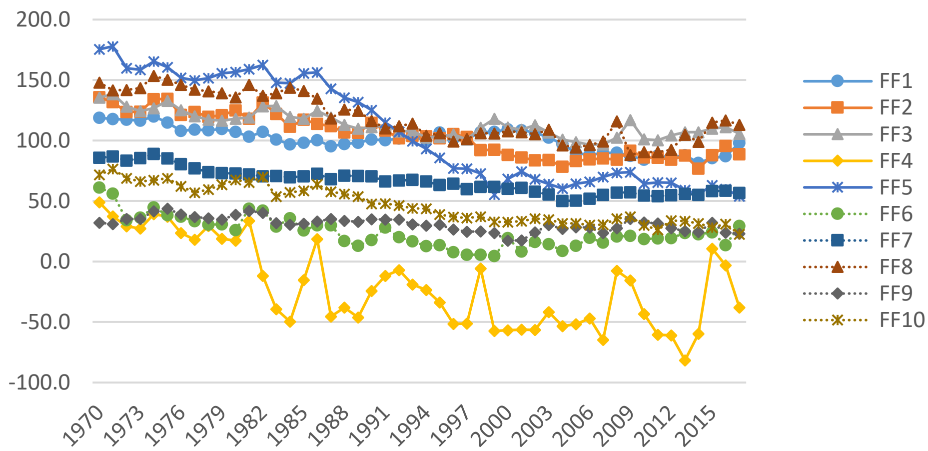


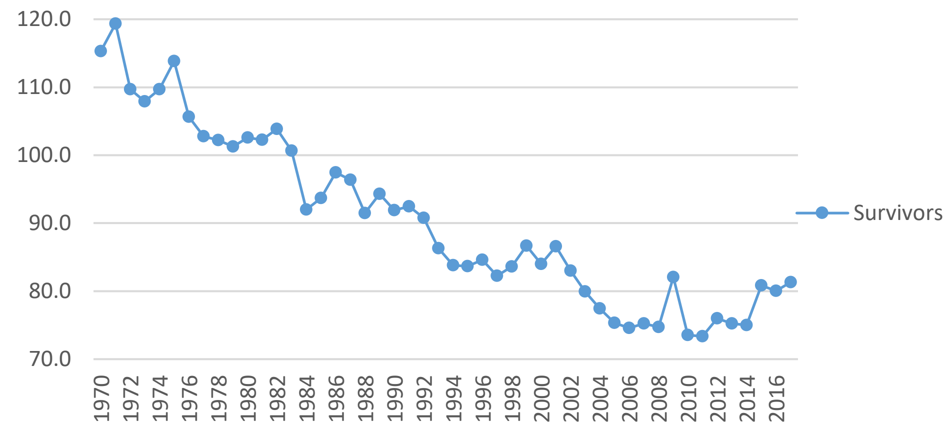
Table 4. Cash Conversion Cycle over Time by Cohort Firms (1970-2017)

Table 4 shows the intertemporal trends in CCC, DSO, DIO and DPO over time for surviving firms and by cohort of firms. CCC is defined as DSO + DIO – DPO. DSO is defined as $\frac{(AR_t+AR_{t-1})/2}{Sales/360}$, DIO is defined as $\frac{(Inv_t+Inv_{t-1})/2}{COGS/360}$ and DPO is defined as $\frac{(AP_t+AP_{t-1})/2}{Purchase/360}$. Survivors are the subset of firms that survive continuously through 1970-2017. Cohort firms are assigned to their respective groups based on the year of first appearance on Compustat database. Asterisks *, **, and *** denote two-tailed significance at the 10%, 5% and 1% levels, respectively.

Panel A. Mean CCC of surviving firms and by cohort firms over time (1970-2017)

	Survivors	<1970s	1970s	1980s	1990s	2000s	2010s
1970s	108.8	106.6	94.1				
1980s	97.5	94.0	101.3	89.1			
1990s	86.6	79.7	89.8	79.6	60.1		
2000s	79.3	72.5	77.2	76.2	63.5	44.1	
2010s	76.9	68.4	71.3	80.4	74.7	53.0	29.2
Time Trends							
Coefficient	-0.86***	-1.02***	-0.70***	-0.36***	0.78***	1.65***	10.26***
(t-statistics)	*(-19.13)*	*(-22.35)*	*(-8.79)*	*(-2.92)*	*(5.54)*	*(3.73)*	*(5.52)*
R^2	0.886	0.914	0.624	0.173	0.533	0.447	0.831

Panel B. Mean CCC of surviving firms over time (1970-2017)



Panel C. Mean CCC by cohort firms over time (1970-2017)

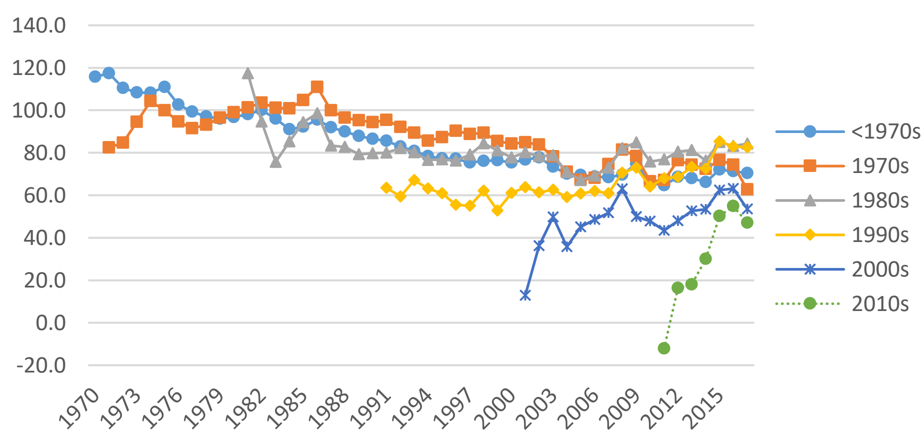


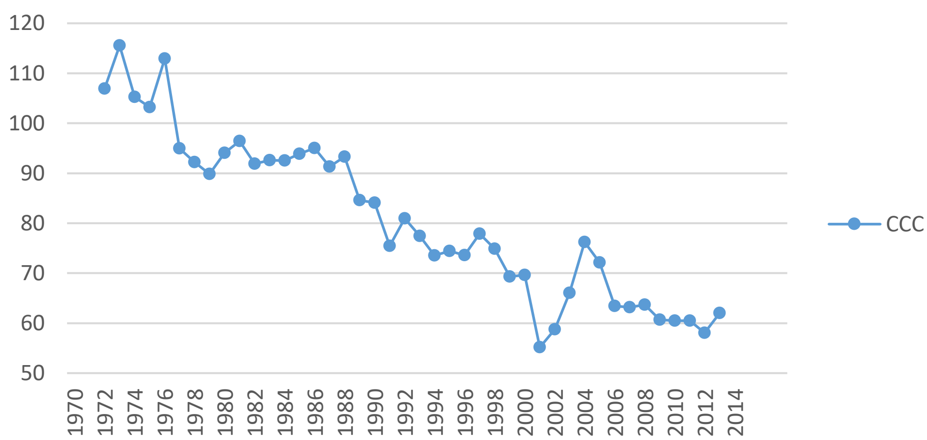
Table 5. 5-year Rolling Average Cash Conversion Cycle over Time (1970-2017)

Table 5 shows the intertemporal trends in CCC, DSO, DIO and DPO, calculated on 5-year rolling average basis. CCC is defined as DSO + DIO – DPO. DSO is defined as $\frac{(AR_t+AR_{t-1})/2}{Sales/360}$, DIO is defined as $\frac{(Inv_t+Inv_{t-1})/2}{COGS/360}$ and DPO is defined as $\frac{(AP_t+AP_{t-1})/2}{Purchase/360}$. All variables used to calculated DSO, DIO, and DPO are obtained from 5-year rolling average. Asterisks *, **, and *** denote two-tailed significance at the 10%, 5% and 1% levels, respectively.

Panel A. 5-year rolling average CCC, DSO, DIO and DPO

	CCC	DSO	DIO	DPO
1970s	102.6	56.4	89.2	44.6
1980s	92.6	60.5	84.7	52.6
1990s	76.2	59.1	67.2	50.2
2000s	64.9	58.7	61.2	55.0
2010s	60.3	56.2	61.9	57.8
Time Trends				
Coefficient	-1.00***	0.15	-0.82***	0.34***
(t-statistics)	*(-6.37)*	*(1.05)*	*(-16.05)*	*(6.30)*
R^2	0.46	0.00	0.85	0.45

Panel B. 5-year rolling average CCC over time (1970-2017)



Panel C. 5-year rolling average DSO, DIO and DPO over time (1970-2017)

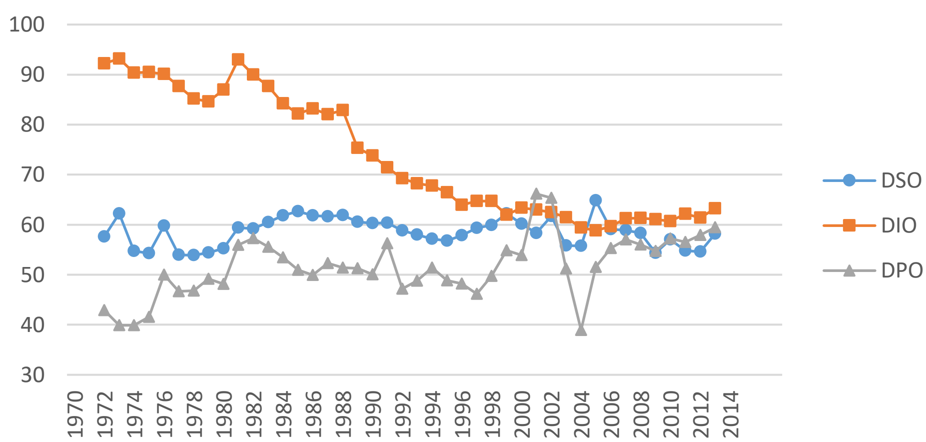


Table 6. Information Technology and Cash Conversion Cycle

Table 6 examines the impact of the development of information technology on cash conversion cycle. The dependent variable in columns 1 through 4, $CCC_{i,t}$, is cash conversion cycle as defined in equation (1). The dependent variable in column 5 is change in cash conversion cycle ($\Delta CCC_{i,t}$). $Time_t$ is the number of years since 1970. $IT\_Spending_{m,t}$ is defined as the percentage increase in ICT spending as provided by the Census Bureau. *Log_AUDIT* is defined as the natural logarithm of hierarchical audit opinion variable. *DTR2* is the adjusted R^2 from annual cross-sectional estimation of Dichev and Tang (2008) model. *Loss* is an indicator variable that equals to 1 if income before extraordinary items (Compustat IB) is negative, and zero otherwise. *Interest_Cover* is defined as interest expense (Compustat XINT) divided by income before extraordinary items (Compustat IB). *Ln_SIZE* is defined as the natural logarithm of total assets. *Growth* is defined as market-to-book ratio (Compustat CSHO*PRCC_F/CEQ). Asterisks *, **, and *** denote two-tailed significance at the 10%, 5% and 1% levels, respectively.

	CCC				Δ*CCC*
	(1)	(2)	(3)	(4)	(5)
Intercept	53.99***	68.93***	44.17***	-19.68	41.06
	(6.60)	(107.82)	(5.43)	(-0.38)	(1.19)
Time	-0.02**		0.65***	-0.13	0.11
	(-2.28)		(3.05)	(-0.20)	(0.21)
IT Spending (Δ*IT Spending*)		-109.74***	-111.02***	-16.44**	-6.70*
		(-21.18)	(-21.36)	(-2.41)	-(1.70)
Audit Opinion (Δ*Audit Opinion*)				-5.33	-5.69
				(-0.46)	-(0.50)
Matching (Δ*Matching*)				54.29	3.10
				(1.44)	(0.25)
Loss				-7.81**	-2.02
				(-2.47)	-(0.73)
Interest Coverage (Δ*Interest Coverage*)				-1.31**	-0.57
				(-2.01)	-(1.36)
Size (Δ*Size*)				1.54	0.32
				(1.35)	(0.03)
Growth (Δ*Growth*)				-0.21	0.39
				(-0.49)	(1.12)
Industry FE	No	No	No	Yes	Yes
Cohort FE	No	No	No	Yes	Yes
Clustered SE	No	No	No	Firm	Firm
#Observations	27,615	27,615	27,615	9,222	5,385
Adj. R2	0.002	0.016	0.016	0.232	0.005

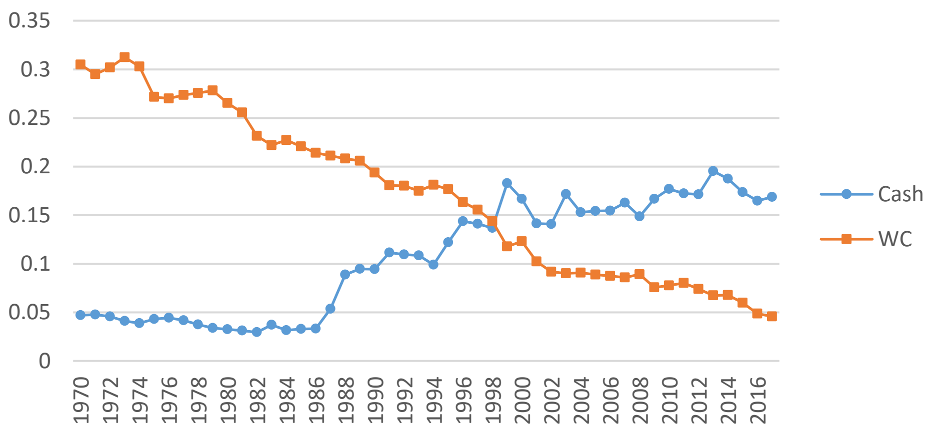
Table 7. Impact on Asset Structure

Table 7 shows the intertemporal trends in Cash, WC, COA, COL and Liquidity ratios over time. Cash is defined as cash (Compustat CH) divided by average total assets. COA is defined as current operating assets (Compustat ACT-CHE) divided by average total assets. COL is defined as current operating liabilities (Compustat LCT-DLC) divided by average total assets. WC is defined as COA less COL. Liquidity excluding cash is defined as COA divided by COL. Liquidity including cash is defined as COA plus Cash divided by COL. Asterisks *, **, and *** denote two-tailed significance at the 10%, 5% and 1% levels, respectively.

Panel A. Cash, WC, and Liquidity ratio over time

	Cash	WC	COA	COL	Liquidity *excl.* Cash	Liquidity *incl.* Cash
1970s	0.04	0.29	0.49	0.21	2.63	2.91
1980s	0.05	0.23	0.43	0.21	2.29	2.66
1990s	0.12	0.17	0.38	0.22	1.99	2.83
2000s	0.16	0.09	0.30	0.21	1.65	2.70
2010s	0.18	0.07	0.27	0.21	1.56	2.72
Time Trends						
Coefficient	0.004***	-0.006***	-0.006***	0.000	-0.029***	-0.004***
(t-statistics)	*(17.17)*	*(-45.63)*	*(-31.36)*	*(1.31)*	*(-30.43)*	*(-2.31)*
R^2	0.862	0.978	0.954	0.015	0.952	0.084

Panel B. Cash and WC over time (1970-2017)



Panel C. Liquidity ratios over time (1970-2017)

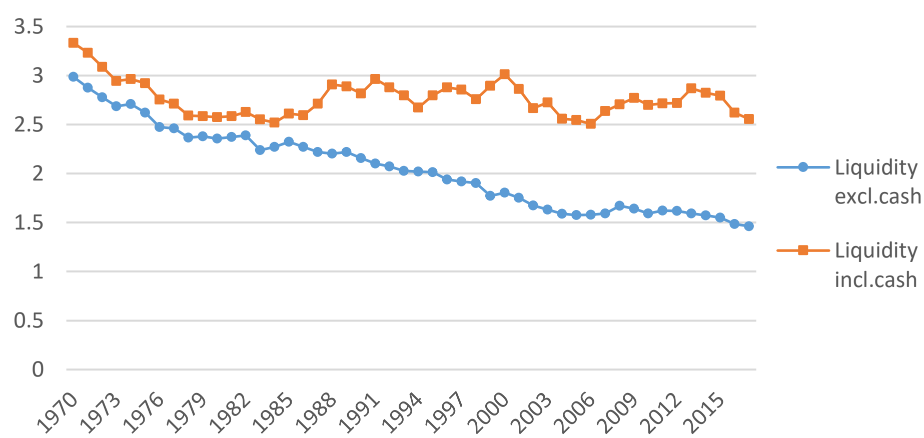


Table 8. Determinants of Cash Holdings

Table 8 provides the OLS regression of cash on various determinants of cash holdings. Columns 1-3 are based on level variables, while columns 4-6 are based on change variables. $Cash_{i,t}$ is cash divided by average total assets. $Liquidity_{i,t}$ is liquidity ratio defined as the current operating assets divided by current operating liabilities. $VolCFO_{i,t}$ is defined as the trailing 5 year standard deviation of operating cash flows divided by average total assets. $Capex_{i,t}$ is defined as capital expenditure divided by average total assets. $R\&D_{i,t}$ is defined as research and development expenditure divided by average total assets. $Size_{i,t}$ is defined as the natural logarithm of total assets. $\%Foreign_{i,t}$ is defined as the absolute value of foreign exchange income (loss) divided by average total assets. $Dividend_{i,t}$ is defined as the sum of ordinary and preferred dividend and stock repurchases divided by income before extraordinary items. $Growth_{i,t}$ is defined as the market-to-book ratio. $Leverage_{i,t}$ is defined as the interest-bearing debt divided by average total assets. Asterisks *, **, and *** denote two-tailed significance at the 10%, 5% and 1% levels, respectively.

	Dep.Var. = $Cash_{i,t}$			Dep.Var. = $\Delta Cash_{i,t}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.177***	0.137***	0.142***	-0.005***	0.000	0.001
	(201.16)	(120.32)	(17.09)	(-12.13)	(-1.45)	(0.21)
$Liquidity_{i,t}$ ($\Delta Liquidity_{i,t}$)	-0.030***	-0.017***	-0.011***	-0.013***	-0.013***	-0.013***
	(-79.78)	(-56.32)	(-14.87)	(-22.00)	(-24.14)	(-16.01)
$VolCFO_{i,t}$ ($\Delta VolCFO_{i,t}$)		0.254***	0.222***		0.081***	0.082***
		(67.36)	(19.88)		(12.40)	(5.91)
$Capex_{i,t}$ ($\Delta Capex_{i,t}$)		-0.223***	-0.097***		-0.092***	-0.086***
		(-38.12)	(-9.67)		(-13.53)	(-9.83)
$RD_{i,t}$ ($\Delta RD_{i,t}$)		0.482***	0.423***		-0.202***	-0.199***
		(101.40)	(25.48)		(-20.24)	(-6.49)
$Size_{i,t}$ ($\Delta Size_{i,t}$)		0.000***	0.000***		0.000*	0.000**
		(-16.00)	(-16.18)		(1.74)	(2.13)
$Foreign_{i,t}$ ($\Delta Foreign_{i,t}$)		0.914***	0.697**		-0.098	-0.035
		(4.90)	(2.17)		(-0.55)	(-0.18)
$Dividend_{i,t}$ ($\Delta Dividend_{i,t}$)		-0.001***	-0.001***		-0.001***	-0.001***
		(-4.08)	(-2.94)		(-6.58)	(-5.60)
$Growth_{i,t}$ ($\Delta Growth_{i,t}$)		0.002***	0.002***		0.001***	0.001***
		(27.81)	(8.91)		(11.81)	(4.64)
$Leverage_{i,t}$ ($\Delta Leverage_{i,t}$)		-0.139***	-0.120***		-0.019***	-0.018***
		(-76.63)	(-27.02)		(-6.60)	(-2.88)
Industry FE	No	No	Yes	No	No	Yes
Year FE	No	No	Yes	No	No	Yes
Clustered SE	No	No	Firm	No	No	Firm
Number of Observations	125,112	96,769	96,769	113,791	88,142	88,142
Adj. R2	0.048	0.339	0.389	0.004	0.018	0.025

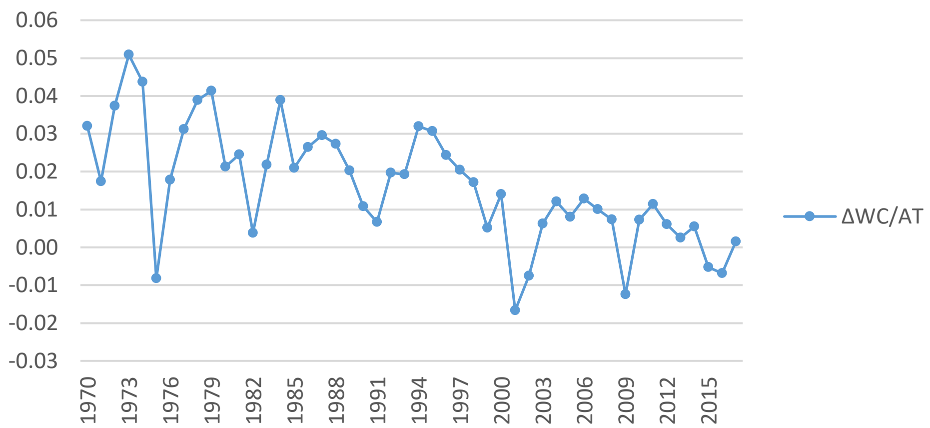
Table 9. Intertemporal Trends in Working Capital Accruals

Table 9 shows the intertemporal trends in working capital accruals as a proportion of assets, earnings, change in sales, and change in expenses. ΔWC is defined as change in WC. WC is defined as COA less COL. COA is defined as current operating assets (Compustat ACT-CHE) divided by average total assets. COL is defined as current operating liabilities (Compustat LCT-DLC) divided by average total assets. E is defined as earnings before extraordinary items. Asterisks *, **, and *** denote two-tailed significance at the 10%, 5% and 1% levels, respectively.

Panel A. Working capital accruals over time

	ΔWC/AT	ΔWC/E	ΔWC/ΔSales	ΔWC/ΔExpense
1970s	0.030	0.188	0.183	0.177
1980s	0.023	0.205	0.125	0.175
1990s	0.019	0.178	0.112	0.147
2000s	0.003	0.074	0.063	0.068
2010s	0.003	0.054	0.036	0.067
Time Trends				
Coefficient	-0.001***	-0.004***	-0.004***	-0.003***
(t-statistics)	(-6.14)	(-4.59)	(-4.56)	(-4.14)
R^2	0.439	0.300	0.296	0.256

Panel B. Working capital accruals as a proportion of total assets over time (1970-2017)



Panel C. Working capital accruals as a proportion of E, ΔSale, and ΔExpense over time (1970-2017)

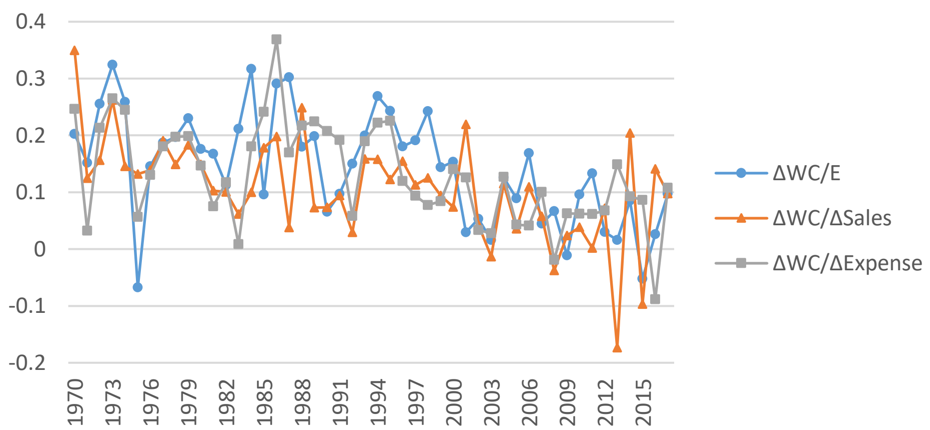


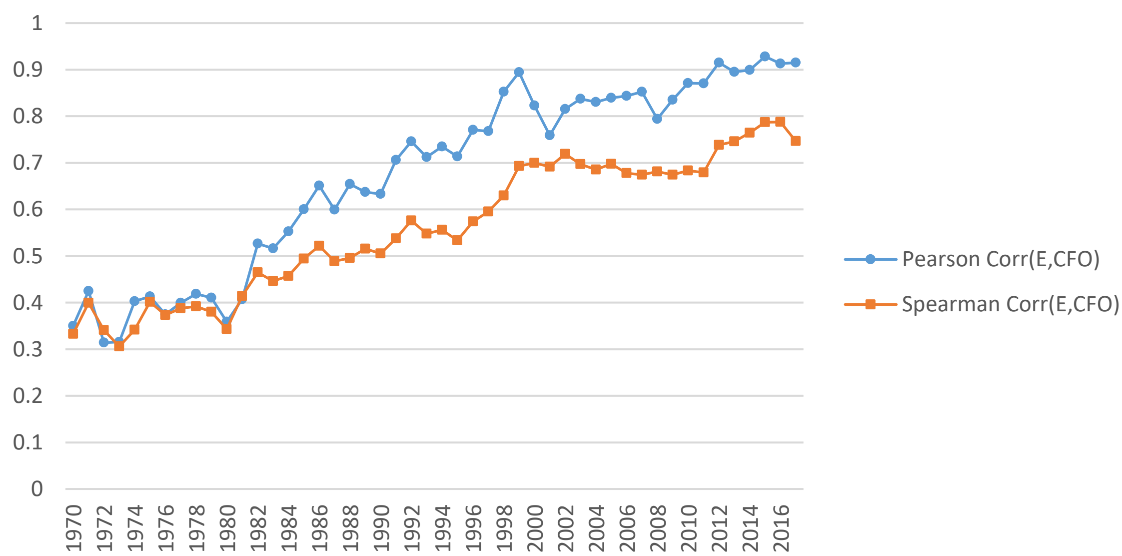
Table 10. Intertemporal Trends in Earnings-Cash Flows Correlations

Table 10 shows the intertemporal trends in the Pearson and Spearman correlation between earnings and cash flows (*Corr(E,CFO)*). E is defined as earnings before extraordinary items divided by average total asset. CFO is defined as the difference between earnings and change in working capital. Asterisks *, **, and *** denote two-tailed significance at the 10%, 5% and 1% levels, respectively.

Panel A. Pearson and Spearman correlation between earnings and cash flows over time

	Pearson Corr(E,CFO)	Spearman Corr(E,CFO)
1970s	0.38	0.37
1980s	0.55	0.46
1990s	0.75	0.57
2000s	0.82	0.69
2010s	0.90	0.74
Time Trends		
Coefficient	0.014***	0.010***
(t-statistics)	(22.23)	(27.50)
R^2	0.913	0.941

Panel B. Pearson and Spearman *Corr(E,CFO)* over time (1970-2017)



Appendix A.
Fama-French 10 Industry Classification

Industry Code	Industry Name
1	Consumer non-Durables (Food, Tobacco, Textiles, Apparel, Leather, Toy)
2	Consumer Durables (Cars, TVs, Furniture, Household Appliances)
3	Manufacturing (Machinery, Trucks, Planes, Chemicals, Office Furniture, Paper, Computer Printing
4	Energy (Oil, Gas, and Coal Extraction and Products)
5	Computer Equipment (Computers, Software, and Electronic Equipment)
6	Telephone and Television Transmission
7	Shops (Wholesale, Retail, Laundries, and Repair Shops)
8	Healthcare, Medical Equipment, and Drugs
9	Utilities
10	Other (Mines, Construction, Building, Transportation, Hotels, Bus Services, Entertainment, Finance)